MORE CALCULATOR AND COMPUTER PROGRAMS FOR EME

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AS-49-29

The first two programs listed in this EME note are for the TRS-80. Stephen Gayeske, WB5LWS, is the author of these versions of the original program by Lance Collister, WA1JXN.

The HP45 calculator program for the moon azimuth and elevation, allowing for parallax, was supplied by G.D. Wall, ZE2KV. This same program can be used to calculate great circle distance and bearing between two locations on earth.

Brian Manns, K3VGX, submitted the TI58/59 program for determining the sun or moon azimuth and elevation using data from the Nautical Almanac.

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'MOON LOCATION PROGRAM FOR LEVEL II 16K TRS-80 RADIO SHACK COMPUTER

560 LET P5=2.0000000000*3.1415926535
570 LET D5=360.0000000000/P5
580 LET R5=P5/360.0000000000
590 INPUT "WHAT IS THE LATITUDE IN DEGREES, MINUTES";L5,U5
610 INPUT "WHAT IS THE LONGITUDE IN DEGREES, MINUTES";L6,U6
630 LET L5=(L5+U5/60)*R5
640 LET L6=(L6+U6/60)*R5
650 INPUT"WHAT IS THE DESIRED PRINTING INCREMENT IN MINUTES";I
670 INPUT"DO YOU ONLY WANT PRINTOUT WHEN THE MOON IS NEAR THE HORIZON";B$
700 IF B$="YES" THEN 730
710 LET I6=100
720 GOTO 800
730 INPUT"BELOW WHAT ELEV. IN DEGREES DO YOU WANT PRINTOUT TO OCCUR";I6$
750 INPUT"WHAT ARE THE GMT MONTH,DAY,YEAR DESIRED";M,D,Y
780 IF M=0 THEN END
790 GOTO 900
800 INPUT"WHAT ARE THE GMT MONTH,DAY,YEAR,TIME INTERVAL(BEGINNING,ENDING) DESIRE
D";M,D,Y,B,E1
840 IF M=0 THEN END
880 IF B$="YES" THEN 900
890 GOTO 1000
900 E1=2400
910 B=0
920 GOTO 1000
980 LET Y1=Y-(INT(Y/100)*100)
1000 PRINT
1010 PRINT"POSITION OF MOON ON " ;M;"/";D;"/";Y;" ";B;"-";E1" GMT ="
1020 PRINT
1030 PRINT" GMT";TAB(15)"AZ";TAB(30)"EL";TAB(45)"GHA";TAB(60)"DEC"
1040 PRINT" ---";TAB(15)"--";TAB(30)"--";TAB(45)"---";TAB(60)"---"
1050 PRINT
1060 LET I1=2
1070 REM HERE BEGINS CALCULATION OF JULIAN DATE
1080 IF M>=3 THEN 1160
1090 IF INT((Y-1853)/4)<11 THEN 1120
1100 LET C1=-1
1110 GOTO 1130
1120 LET C1=0
1130 LET J1=365*(Y-1853)+D+30*(M+9)+INT((M+10)/2)
1140 LET J2=INT((Y-1853)/4)+1+C1
1150 GOTO 1270
1160 IF INT((Y-1852)/4)<11 THEN 1190
1170 LET C1=-1
1180 GOTO 1200
1190 LET C1=0
1200 IF M=9 THEN 1240
1210 IF M=11 THEN 1240
1220 LET C2=0
1230 GOTO 1250
1240 LET C2=1
1250 J1=365*(Y-1852)+D+30*(M-3)+INT((M-2)/2)
1260 LET J2=INT((Y-1852)/4)+C1+C2
1270 LET J=J1+J2
1275 REM (JULIAN DATE-2397547.5) FOR 0 HOURS GMT
1280 LET T1=J-17472.5
1290 LET D9 =(B-INT(B/100)*100)+INT(B/100)*60
1300 LET D6=(E1-INT(E1/100)*100)+INT(E1/100)*60
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1310 LET O7=O9-O6
1320 LET O8=O7-I
1330 IF O7>0 THEN 1350
1340 GOTO 1380
1350 IF O8>=0 THEN 2240
1360 LET B=E1
1380 LET T=(B-INT(B/100)*100)/1440+INT(B/100)/24
1390 LET T5=T1+T
1400 K1=((.751213+.036601102*T5)-INT(.751213+.036601102*T5))*P5
1410 K2=((.822513+.0362916457*T5)-INT(.822513+.0362916457*T5))*P5
1420 K3=((.995766+.00273777852*T5)-INT(.995766+.00273777852*T5))*P5
1430 K4=((.974271+.0338631922*T5)-INT(.974271+.0338631922*T5))*P5
1440 K5=((.0312525+.0367481957*T5)-INT(.0312525+.0367481957*T5))*P5
1450 LET L8=K1+.658*R5*SIN(2*K4)+6.289*R5*SIN(K2)
1460 LET L8=L8-1.274*R5*SIN(K2-2*K4)-.186*R5*SIN(K3)
1470 LET L8=L8+.214*R5*SIN(2*K2)-.114*R5*SIN(2*K5)
1480 LET L8=L8-.059*R5*SIN(2*K2-2*K4)-.057*R5*SIN(K2+K3-2*K4)
1490 LET K6=K5+.6593*R5*SIN(2*K4)+6.2303*R5*SIN(K2)-1.272*R5*SIN(K2-2*K4)
1500 LET L7=5.144*R5*SIN(K6)-.146*R5*SIN(K5-2*K4)
1520 LET O1=COS(L7)*SIN(L8)*.397821+SIN(L7)*.917463
1530 LET D1=ATN(O1/(SQR(1-O1↑2)))
1540 LET A2=COS(L7)*COS(L8)/COS(O1)
1550 LET A1=(COS(L7)*SIN(L8)*.917463-SIN(L7)*.397821)/COS(D1)
1560 LET A=ATN(A1/A2)
1570 GOSUB 1870
1580 LET R1=A
1590 LET L1=.065709822*T1
1600 LET L=T*24*1.002738+6.646055+(L1-INT(L1/24)*24)
1610 LET L=(L-INT(L/24)*24)
1630 LET G=(L/24)*P5-R1
1640 IF G<P5 THEN 1670
1650 G=G-P5
1660 GOTO 1710
1670 IF G<0 THEN 1690
1680 GOTO 1710
1690 G=G+P5
1710 LET H=L6-G
1730 LET E3=COS(L5)*COS(H)*COS(D1)+SIN(O1)*SIN(L5)
1740 LET E2=SQR(1-(E3*E3))
1750 LET E=ATN(E3/E2)
1760 IF E<0 THEN 2170
1770 IF E>I6*R5 THEN 2170
1790 LET A2=SIN(O1)/(COS(L5)*COS(E))
1800 LET A2=A2-(SIN(L5)/COS(L5))*(SIN(E)/COS(E))
1810 LET A1=SIN(L5)*SIN(O1)+COS(L5)*COS(O1)*COS(H)
1820 LET A1=(SIN(H)*COS(D1))/(SQR(1-A1↑2))
1830 LET A=ATN(A1/A2)
1840 GOSUB 1870
1850 GOTO 2020
1860 REM
1870 IF A=0 THEN 1890
1880 GOTO 1930
1890 IF A2<0 THEN 1910
1900 GOTO 2010
1910 LET A=P5/2
1920 GOTO 2010
1930 IF A>0 THEN 1990
1940 IF A2<0 THEN 1970
1950 LET A=P5+A
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```
1960 GOTO 2010
1970 LET A=P5+(A-P5/2)
1980 GOTO 2010
1990 IF A2>=0 THEN 2010
2000 LET A=A+P5/2
2010 RETURN
2020 IF(T-I1)>(2*I)/1440 THEN 2040
2030 GOTO 2150
2040 PRINT
2150 PRINT (INT(B+.5));TAB(13)INT(A*D5*10*+.5)/10*2;TAB(28)INT(E*05*10+.5)/10;TA
B(43)INT(G*05*10+.5)/10;TAB(59)INT(01*05*10+.5)/10
2160 LET I1=T
2170 LET B=B+I
2180 LET Z=(B-INT(B/100)*100)-60
2190 IF Z<0 THEN 1290
2200 LET B=INT(B/100)*100+100+Z
2210 GOTO 1290
2240 PRINT
2250 PRINT
2260 PRINT
2270 PRINT"DO YOU WANT MORE INFORMATION?":
2280 INPUT O$
2290 IF O$="YES" THEN 650
2300 END
```

MOON LOCATION PROGRAM FOR RADIO SHACK TRS-80 DISK BASIC

```
340 DEFFNA(X)=INT(X*D5*10+.5)/10
350 DEFFNB(X)=(X-INT(X))*P5
360 LET P5=2.0000000000*3.1415926535
370 LET D5=360.0000000000/P5
380 LET R5=P5/360.0000000000
390 PRINT"WHAT IS THE LATITUDE IN DEGREES, MINUTES";
400 INPUT L5,U5
410 PRINT"WHAT IS THE LONGITUDE IN DEGREES, MINUTES";
420 INPUT L6,U6
430 LET L5=(L5+U5/60)*R5
440 LET L6=(L6+U6/60)*R5
450 PRINT"WHAT IS THE DESIRED PRINTING INCREMENT IN MINUTES";
460 INPUT I
470 PRINT"DO YOU ONLY WANT PRINTOUT WHEN THE MOON IS NEAR THE HORIZON";
480 INPUT B$
490 IF B$="YES" THEN 520
500 LET I6=100
510 GOTO 570
520 PRINT"BELOW WHAT ELEV. IN DEGREES DO YOU WANT PRINTOUT TO OCCUR";
530 INPUT I6$
540 PRINT"WHAT ARE THE GMT MONTH,DAY,YEAR DESIRED";
550 IF M=0 THEN END
560 GOTO 620
570 PRINT"WHAT ARE THE GMT MONTH,DAY,YEAR,TIME INTERVAL(BEGINNING,ENDING) DESIRE
D";
580 INPUT M,D,Y,B,E1
590 IF M=0 THEN END
600 IF B$="YES" THEN 620
610 GOTO 660
620 E1=2400
630 B=0
640 GOTO 660
650 LET Y1=Y-(INT(Y/100)*100)
660 PRINT
670 PRINT"POSITION OF MOON ON " ;M;"/";D;"/";Y;" ";B;"-";E1" GMT ="
680 PRINT
690 PRINT" GMT";TAB(15)"AZ";TAB(30)"EL";TAB(45)"GHA";TAB(60)"DEC"
700 PRINT" ---";TAB(15)"--";TAB(30)"--";TAB(45)"---";TAB(60)"---"
710 PRINT
720 LET I1=2
730 REM HERE BEGINS CALCULATION OF JULIAN DATE
740 IF M>=3 THEN 820
750 IF INT((Y-1853)/4)<11 THEN 780
760 LET C1=-1
770 GOTO 790
780 LET C1=0
790 LET J1=365*(Y-1853)+D+30*(M+9)+INT((M+10)/2)
800 LET J2=INT((Y-1853)/4)+1+C1
810 GOTO 930
820 IF INT((Y-1852)/4)<11 THEN 850
830 LET C1=-1
840 GOTO 860
850 LET C1=0
860 IF M=9 THEN 900
870 IF M=11 THEN 900
880 LET C2=0
890 GOTO 910
900 LET C2=1
```

```
910 J1=365*(Y-1852)+D+30*(M-3)+INT((M-2)/2)
920 LET J2=INT((Y-1852)/4)+C1+C2
930 LET J=J1+J2
940 REM (JULIAN DATE-2397547.5) FOR 0 HOURS GMT
950 LET T1=J-17472.5
960 LET D9 =(B-INT(B/100)*100)+INT(B/100)*60
970 LET D6=(E1-INT(E1/100)*100)+INT(E1/100)*60
980 LET D7=D9-D6
990 LET D8=D7-I
1000 IF D7>0 THEN 1020
1010 GOTO 1040
1020 IF D8>=0 THEN 1910
1030 LET B=E1
1040 LET T=(B-INT(B/100)*100)/1440+INT(B/100)/24
1050 LET T5=T1+T
1060 K1=FNB(.751213+.036601102*T5)
1070 K2=FNB(.822513+.0362916457*T5)
1080 K3=FNB(.995766+.00273777852*T5)
1090 K4=FNB(.974271+.0338631922*T5)
1100 K5=FNB(.0312525+.0367481957*T5)
1110 LET L8=K1+.658*R5*SIN(2*K4)+6.289*R5*SIN(K2)
1120 LET L8=L8-1.274*R5*SIN(K2-2*K4)-.186*R5*SIN(K3)
1130 LET L8=L8+.214*R5*SIN(2*K2)-.114*R5*SIN(2*K5)
1140 LET L8=L8-.059*R5*SIN(2*K2-2*K4)-.057*R5*SIN(K2+K3-2*K4)
1150 LET K6=K5+.6593*R5*SIN(2*K4)+6.2303*R5*SIN(K2)-1.272*R5*SIN(K2-2*K4)
1160 LET L7=5.144*R5*SIN(K6)-.146*R5*SIN(K5-2*K4)
1170 LET D1=COS(L7)*SIN(L8)*.397821+SIN(L7)*.917463
1180 LET D1=ATN(D1/(SQR(1-D1↑2)))
1190 LET G1=50.5+((D1)/(.792))*D5
1200 LET G2=80+((D1)/(.808))*D5
1210 LET G3=141.5-((D1)*(.738)*D5)
1220 LET G4=170.5-((D1)*(.857)*D5)
1230 LET A2=COS(L7)*COS(L8)/COS(D1)
1240 LET A1=(COS(L7)*SIN(L8)*.917463-SIN(L7)*.397821)/COS(D1)
1250 LET A=ATN(A1/A2)
1260 GOSUB 1520
1270 LET R1=A
1280 LET L1=.065709822*T1
1290 LET L=T*24*1.002738+6.646055+(L1-INT(L1/24)*24)
1300 LET L=(L-INT(L/24)*24)
1310 LET G=(L/24)*P5-R1
1320 IF G<P5 THEN 1350
1330 G=G-P5
1340 GOTO 1380
1350 IF G<0 THEN 1370
1360 GOTO 1380
1370 G=G+P5
1380 LET H=L6-G
1390 LET E3=COS(L5)*COS(H)*COS(D1)+SIN(D1)*SIN(L5)
1400 LET E2=SQR(1-(E3*E3))
1410 LET E=ATN(E3/E2)
1420 IF E<0 THEN 1860
1430 IF E>I6*R5 THEN 1860
1440 LET A2=SIN(D1)/(COS(L5)*COS(E))
1450 LET A2=A2-(SIN(L5)/COS(L5))*(SIN(E)/COS(E))
1460 LET A1=SIN(L5)*SIN(D1)+COS(L5)*COS(D1)*COS(H)
1470 LET A1=(SIN(H)*COS(D1))/(SQR(1-A1↑2))
1480 LET A=ATN(A1/A2)
```

```
1490 GOSUB 1520
1500 GOTO 1670
1510 REM
1520 IF A=0 THEN 1540
1530 GOTO 1580
1540 IF A2<0 THEN 1560
1550 GOTO 1660
1560 LET A=P5/2
1570 GOTO 1660
1580 IF A>0 THEN 1640
1590 IF A2<0 THEN 1620
1600 LET A=P5+A
1610 GOTO 1660
1620 LET A=P5+(A-P5/2)
1630 GOTO 1660
1640 IF A2>=0 THEN 1660
1650 LET A=A+P5/2
1660 RETURN
1670 IF(T-I1)>(2*I)/1440 THEN 1690
1680 GOTO 1700
1690 PRINT
1700 IF FNA(D1)<0 THEN 1830
1710 IF FNA(G)<G1 THEN 1830
1720 IF FNA(G)>G2 THEN 1740
1730 GOTO 1770
1740 IF FNA(G)<G3 THEN 1790
1750 IF FNA(G)>G4 THEN 1830
1760 GOTO 1810
1770 LET S$="U"
1780 GOTO 1840
1790 LET S$="W"
1800 GOTO 1840
1810 LET S$="J"
1820 GOTO 1840
1830 LET S$=" "
1840 PRINT(INT(B+.5));TAB(13)FNA(A);TAB(28)FNA(E);TAB(43)FNA(G);TAB(56)FNA(D1)S$
1850 LETI1=T
1860 LET B=B+I
1870 LET Z=(B-INT(B/100)*100)-60
1880 IF Z<0 THEN 960
1890 LET B=INT(B/100)*100+100+Z
1900 GOTO 960
1910 PRINT
1920 INPUT"DO YOU WANT MORE INFORMATION";D$
1930 IF D$="YES" THEN 450
1940 END
1970 REM U=EUROPEAN UNIVERSAL WINDOW
1980 REM W=VE-W WINDOW
1990 REM J=JA-VK-ZL WINDOW
```

MOON AZ-EL ROUTINE FOR HP45

Allowing for Parallax

(May also be used for Great Circle bearing and distance calculations)

G.D. Wall ZE2KV

Moon Az-El Calculations

Preliminary: (a) Longitude to STO 1 (degrees and decimals).
Longitude East positive, West negative.

(b) Colatitude for North elevated pole to STO 2 (degrees and decimals).
Colat for northern latitudes = 90 - Lat
Colat for southern latitudes = 90 + Lat

(c) Horizontal Parallax to STO 3 (degrees and decimals). Obtain from the Nautical Almanac

Routine:

Read in GHA (OMS) DMS→ RCL 1 + Note if less than 360* COS RCL 2 SIN STO 4 x 90 ENTER

Read in OEC (OMS) North positive South negative OMS → -

STO 5 SIN x RCL 2 COS STO 6 RCL 5 COS

STO 5 x + ENTER COS^{-1} ENTER (STO 8) SIN

STO 7 RCL 3 x + CHS 90 + Read Elevation

x-y RCL 6 x CHS RCL 5 + RCL 4 RCL 7 x

$\frac{*}{*}$ COS^{-1} If * less than 360 Read Azimuth otherwise proceed

CHS 360 + Read Azimuth

At Test Point * less than 360 means values of 180 through 270 to 360, and negative values through -90 to -180

Test:

Location	36^{o} - 45' - 40" N	
	119^{o} - 47' - 10" W	
Horizontal Parallax		56.4'
GHA		85^{o} - 33.6'
Declination		13^{o} - 21.2' S
Read:	Elevation	29.61^{o}
	Azimuth	140.61^{o}

Great Circle calculations

1. Home station data is entered into STO 1 and STO 2 as before. STO 3 is zero.
2. Enter the longitude of the distant point at GHA but with reversed sign, i.e., Long 120 W = 120
   Long 50 E = -50
3. Enter the latitude of the distant point at DEC. Positive for North latitudes, negative for South.
4. Great Circle angular distance is stored at STO 8 for future use.
5. Bearing of the distant station is read at Azimuth.
6. Great Circle distance is then obtained:
   RCL 8 69.057 x Read (in miles)
   RCL 8 111.14 x Read (in kilometers)
7. Part of the parallax correction routine is not used in the Great Circle calculations and may be omitted. Miss out the steps (RCL 3 ..... Read Elevation x-y) but roll down twice after STO 7 and before RCL 6.

Test: Fresno 36^{o} - 45' - 40" N; 119^{o} - 47' - 10" W
to Salisbury, Rhodesia 18^{o}S; 31^{o}E
Read: Bearing 62.77^{o} Distance 10235 miles

AZ/EL COORDINATES FOR THE SUN OR MOON USING THE T.I. 58/59 AND THE NAUTICAL ALMANAC

The following program supplies AZ/EL coordinates from any latitude/longitude for the sun or moon using the hourly GHA information presented in the Nautical Almanac. This program also allows for 15 minute increments between the hourly GHA's.

I. PROGRAM INSTRUCTIONS

A. To load the program press: 1) 2nd. CE

2) 2nd. CMS

3) 1 2nd. OP 17

4) LRN

Begin at Step 000 and end at Step 228. (Note: The display will read 229 00 when completed.)

*IMPORTANT! MOONRISE: There are times at moonrise when the moon's GHA (per the Nautical Almanac) is $<300^{o}$. Only at these times the normal computed answer per the formula must be subtracted from 360^{o} to give the proper azimuth. To allow the calculator to perform this step, a random number must be chosen which is greater than your moonset GHA but less than say 300^{o}. This number is stored in program steps (82,83,84) (110,111,112) and (136,137,138).
For example, my moonset is around 170^{o} to 180^{o} GHA so I used 200 as my number since it is less than 300^{o} - and - greater than my moonset GHA.

II. USER INSTRUCTIONS

A. Enter desired latitude in degrees, minutes, seconds and convert to decimal degrees; store answer in register 0.

EXAMPLE: 39^{o} 49' 37" would be entered as 39.4937

PRESS	DISPLAY
1) 2nd. OMS	39.82694444
2) STO 00	same

B. Enter desired longitude in degrees, minutes, seconds and convert to decimal degrees; store answer in Register 1.

EXAMPLE: 76^{o} 42' 30" would be entered as 76.4230

PRESS	DISPLAY
1) 2nd. OMS	76.70833333
2) STO 01	same

C. Press "E" - This step is only done when the calculator is initially turned on or when the latitude/longitude has been changed.

D. Enter hourly GHA in degrees, minutes, convert to decimal degrees; store in Register 2 and Register 6.

EXAMPLE: Moon GHA at 1400 UTC on 10/16/79.

PRESS	DISPLAY
1) 9.599	9.599
2) 2nd. OMS	10.00833333
3) STO 03	same

E) Enter hourly declination in degrees, minutes and convert to decimal degrees; store in Register 3. (Note: "__" if southern declination)

EXAMPLE: Moon Declination at 1400 UTC on 10/16/79.

	PRESS	DISPLAY
1)	9.599	9.599
2)	2nd. DMS	1D.D0833333
3)	STO 03	same

		PRESS	DISPLAY
F)	1)	A	Elevation (Ex. 60.06^{o})
	2)	R/S	Azimuth (Ex. 185.9^{o})
G)	1)	8	Elevation @ GHA +15 min. (Ex. 59.61^{o})
	2)	R/S	Azimuth @ GHA +15 min. (Ex. 192.86^{o})
H)	1)	C	Elevation @ GHA +30 min. (Ex. 58.84^{o})
	2)	R/S	Azimuth @ GHA +30 min. (Ex. 199.59^{o})
I)	1)	D	Elevation @ GHA +45 min. (Ex. 57.77^{o})
	2)	R/S	Azimuth @ GHA +45 min. (Ex. 205.99^{o})

NOTE: Keys 8^{1}, C^{1}, D^{1} are used when tracking the sun.

This program provides true bearing readings. If your antenna has been aligned at magnetic North a correction from magnetic to true North must be made or the antenna should be aligned using the North Star. Once you are obtaining echoes from the moon any electrical shift in the antenna pattern will show up by comparing the calculator settings VRS. loudest echoes.

Brian M. Manns K3VGX

10/16/79

PROGRAM EQUATIONS

$$\text{ELEVATION} = \text{SIN}^{-1}\left[(\text{COS}(\text{GHA-LONG})\text{COS.LAT. COS.DEC})+(\text{SIN LAT.SIN DEC})\right]$$

$$\text{AZIMUTH} = \left[\text{COS}^{-1}\left(\frac{\text{SIN DEC}}{\text{COS.EL.COS.LAT}} - (\text{TAN.LAT.TAN.EL})\right)\right]$$

ANTENNA BEARING +

TITLE DISTANCE BETWEEN STATIONS PAGE 1 OF 2

PROGRAMMER BRIAN MANNS K3VGX DATE 10/16/77

TI Programmable Coding Form

LOC	CODE	KEY	COMMENTS
00	76	LBL	2ND.
	11	A	
	43	RCL	
	00	0	
	32	X≷t	
	53	(	
	53	(	
	43	RCL	
	02	2	
	39	COS	2ND.
01	65	×	
	43	RCL	
	00	0	
	30	TAN	2ND.
	55	÷	
	53	(	
	53	(	
	43	RCL	
	03	3	
	75	−	
02	43	RCL	
	01	1	
	54	)	
	38	SIN	2ND.
	54	)	
	54	)	
	75	−	
	53	(	
	43	RCL	
	02	2	
03	38	SIN	2ND.
	65	×	
	53	(	
	53	(	
	43	RCL	
	03	3	
	75	−	
	43	RCL	
	01	1	
	54	)	
04	30	TAN	2ND.
	35	1/x	
	54	)	
	54	)	
	54	)	
	35	1/x	
	22	INV	
	30	TAN	2ND.
	85	+	
	43	RCL	
05	02	2	
	77	X≷t	2ND.
	00	070	> ADR. 070
	70		
	75	−	

LOC	CODE	KEY	COMMENTS
	43	RCL	
	02	2	
	85	+	
	01	1	
	08	8	
06	00	0	
	85	+	
	00	0	
	32	X≷t	
	75	−	
	43	RCL	
	06	6	
	75	−	
07	75	−	
	43	RCL	
	02	2	
	85	+	
	43	RCL	
	01	1	
	32	X≷t	
	75	−	
	43	RCL	
	00	0	
08	85	+	
	43	RCL	
	03	3	
	77	X≷t	2ND.
	01	130	> ADR. 130
	30		
	75	−	
	43	RCL	
	03	3	
	85	+	
09	00	0	
	32	X≷t	
	75	−	
	43	RCL	
	01	1	
	85	+	
	43	RCL	
	00	0	
	32	X≷t	
	85	+	
	43	RCL	
10	02	2	
	67	X=t	2ND.
	01	117	> ADR. 117
	17		
	75	−	
	43	RCL	
	02	2	
	85	+	
	00	0	

LOC	CODE	KEY	COMMENTS
11	32	X≷t	
	75	−	
	43	RCL	
	00	0	
	75	=	
	11	R/S	
	81	RST	
	75	−	
	43	RCL	
	02	2	
12	85	+	
	00	0	
	32	X≷t	
	75	−	
	43	RCL	
	00	0	
	75	=	
	74	+/−	
	91	R/S	
	81	RST	
13	75	−	
	43	RCL	
	03	3	
	85	+	
	03	3	
	06	6	
	00	0	
	85	+	
	00	0	
	32	X≷t	
14	75	−	
	43	RCL	
	01	1	
	95	=	
	42	STO	
	05	5	
	85	+	
	03	3	
	06	6	
	00	0	
15	32	X≷t	
	85	+	
	77	X≷t	2ND.
	01	168	> ADR. 168
	68		
	75	−	
	43	RCL	
	05	5	
	85	+	
	06	0	

MERGED CODES

62 Fix Ind	72 STO Ind	83 GTO Ind
63 Eng Ind	73 RCL Ind	84 Op Ind
64 Sci Ind	74 SUM Ind	92 INV SBR

TEXAS INSTRUMENTS INCORPORATED

TI 2415I

TITLE KINTONNA BEARING + DISTANCE BETWEEN STATIONS PAGE 2 OF 2

PROGRAMMER BRIAN MANNS K3VGX DATE 10/16/77

TI Programmable **Coding Form**

LOC	CODE	KEY	COMMENTS
16	32	X≥t	
	75	−	
	03	3	
	06	6	
	00	0	
	95	=	
	91	R/S	
	81	RST	
	75	−	
	43	RCL	
17	05	5	
	75	−	
	01	1	
	08	8	
	00	0	
	85	+	
	00	0	
	32	X≥t	
	75	−	
	03	3	
18	06	6	
	00	0	
	85	+	
	43	RCL	
	01	1	
	32	X≥t	
	85	+	
	43	RCL	
	03	3	
	67	X=t	2ND.
19	02	204	> ADR. 204
	04		
	75	−	
	43	RCL	
	03	3	
	85	+	
	00	0	
	32	X≥t	
	75	−	
	43	RCL	
20	01	1	
	95	=	
	91	R/S	
	81	RST	
	75	−	
	43	RCL	
	03	3	
	85	+	
	01	1	
	08	8	
21	00	0	
	85	+	
	00	0	
	32	X≥t	
	75	−	

LOC	CODE	KEY	COMMENTS
	43	RCL	
	01	1	
	95	=	
	91	R/S	
	81	RST	
22	76	LBL	2ND.
	12	B	
	53	(	
	53	(	
	43	RCL	
	00	0	
	38	SIN	2ND.
	65	X	
	43	RCL	
	02	2	
23	38	SIN	2ND.
	54	)	
	85	+	
	53	(	
	43	RCL	
	00	0	
	39	COS	2ND.
	65	X	
	43	RCL	
	02	2	
24	39	COS	2ND.
	65	X	
	53	(	
	53	(	
	43	RCL	
	01	1	
	75	−	
	43	RCL	
	03	3	
	54	)	
25	39	COS	2ND.
	54	)	
	54	)	
	54	)	
	22	INV	
	39	COS	2ND.
	65	X	
	06	6	
	09	9	
	93	.	
26	00	0	
	04	4	
	06	6	
	08	8	
	95	=	
	91	R/S	
26	81	RST	
		LRN, RST, CLR	

LOC	CODE	KEY	COMMENTS

MERGED CODES

62	72 STO	83 GTO
63	73 RCL	84
64	74 SUM	92 INV SBR

TEXAS INSTRUMENTS INCORPORATED

TI-24151